Cumulative Risk Assessment Workshop

Cumulative Risk Index Analysis (CRIA)

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Dallas, TX, November 7, 2002

Cumulative Risk Thinking

Lessons Learned on Planning and Scoping for Environmental Risk Assessments

» U.S. EPA, Science Policy Council Draft Document, November 15, 2001

- Consideration of Cumulative Impacts In EPA Review of NEPA Documents

  » U.S. EPA, EPA 315-R-99-002, May 1999

- Framework for Cumulative Risk Assessment (CAFO Example) draft
  http://epa.gov/ncea/raf/frmwrkcra.htm

- CRIA = Watershed Unit Sub area   Degree of Vulnerability   Degree of Impact
- (Total Affected Area ÷ Watershed area)   ×   (scale of 1-5)   ×   (scale of 1-4)
  (scale of 1-5)

- CRIA System Criteria Library (approximately 90 ever evolving indicators in Region 6 GIS)

CUMULATIVE RISK KEY ISSUES

- <u>Define your flavor cumulative risk</u>:

- - aggregate? multiple chemicals, sources, exposure pathways

- legal definitions   (TCLP vs. risk number, use both?)

- - we have plenty of data, how to use it is the problem, many EPA thresholds (Cr, Hg)

- - use the computer, no end to the environmental criteria to look at

- <u>Assessor - Manager Dialogue</u>:

- - human health, ecological, economic, political, social issues (don't ask if you do not want the answer)

- <u>Solution</u>: document the methodology in detail

CUMULATIVE RISK KEY ISSUES

- **Risk Characterization Issues:**
- **Transparency in decision making**
  - **use of models within models**

  Clarity in communication
  - **how do you define environmental concern** (protect most or least fragmented landscape?)

  Consistency in core assumptions and science policies (rainfall)
- **Reasonableness across EPA programs**
  - **risks limited to program interests only** (environmental criteria vs. regulations)

Planning and Scoping Process

- **Defining the stressors** (chemical, physical, biological)

- **Sources of environmental stress** (where do you draw the line)

- **Affected populations** (workers, residents, wildlife, economic stakeholders)

- **Pathways** (human health, ecological, education, social, economic)

- **Temporal considerations** (short and long term impacts)

The Conceptual Model

- **Always a good first step.**

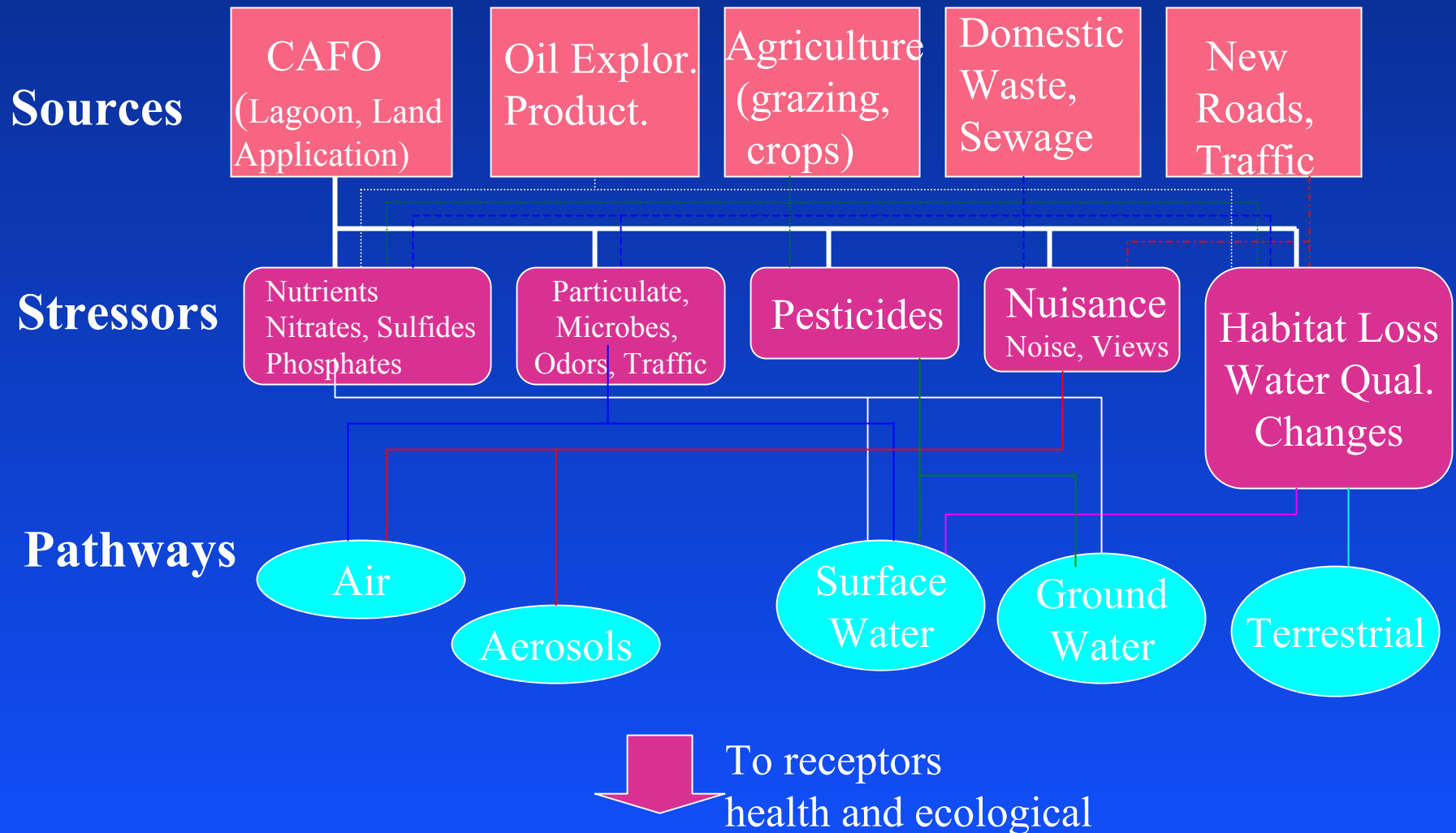 **Example: Confined Animal Feeding Operation (CAFO)**

- **Purpose**: Determine impacts related to CAFOs construction and operation.

- **Scope**:   Watershed – or individual CAFO sites

  (distances from lagoons, land application areas, barns, roads).

- **Technical Approach**:

  GIS / CRIA system approach using landscape, hydrologic, air , ecological, socio-economic and other appropriate analyses.

Cumulative Risk Questions

- **When is a watershed saturated with CAFO cumulative impacts?**

- **What other ecological, human health, and socio-economic stressors contribute to the area's environmental decline?**

- **What positive impacts will result from the action.**

Watershed Preliminary Conceptual Model

Sources

CAFO (Lagoon, Land Application)	Oil Explor. Product.	Agriculture (grazing, crops)	Domestic Waste, Sewage	New Roads, Traffic

Stressors

- Nutrients Nitrates, Sulfides Phosphates
- Particulate, Microbes, Odors, Traffic
- Pesticides
- Nuisance Noise, Views
- Habitat Loss Water Qual. Changes

Pathways

- Air
- Aerosols
- Surface Water
- Ground Water
- Terrestrial

To receptors health and ecological

REGION 6 RISK CHARACTERIZATRION IMPLEMENTATION PLAN

- ## Region 6 Risk Activities (p.11)

- - Category I: Screening, modeling, CRIA, EJI, HRI, multi-media enforcement targeting.

- - Category II: Intermediate level, some monitoring, sampling, supported by Regional guidance, permit related

- - Category III: Superfund / RCRA baseline, Agency regulations / national guidance, extensive sampling

Using a Screening Approach to Assess Cumulative Risk

- **Watersheds** defined spatial components (additive indicator judgments and areas)

- **Points or polygons** defining the industry

- **Vulnerability criteria:** indicators with ranked (1 – 5 scaled) judgments as to environmental concern

-

- **Impact criteria:** 1 – 5 scaled indicators judging stressors presented by CAFO operations

Watershed Vulnerability Assessment Endpoints

- Geology rating
- Rainfall
- Surface water use
- Near residents
- Other industries
- Protected lands
- Water quality
- Road Density
- Wildlife Habitat quality
- Habitat quantity
- Habitat Fragmentation
- Aquifer Rating
- Septic tanks
- Animal units

- Soil permeability
- Nitrates
- Economic status
- Water quantity
- Distance to water
- Other CAFOs
- Stream Flow
- Air Quality
- Ground Water Depth (probability, some measurements)
- TRI Releases to water
- Drinking water wells
- Oil and gas wells

Watershed Vulnerability Assessment Endpoints

- **Habitat Fragmentation (area to perimeter ratio) and quality**

- **Roads (particulates, accidents, spillage, fragmentation, urbanization)**

- **Other land use related pollution sources (landfills, crop land, pasture, oil fields, urban runoff, animal waste)**

- **Flood plains**

- **Air quality (Particulates, NO_x, SO_x, CO, VOCs, Ozone)**

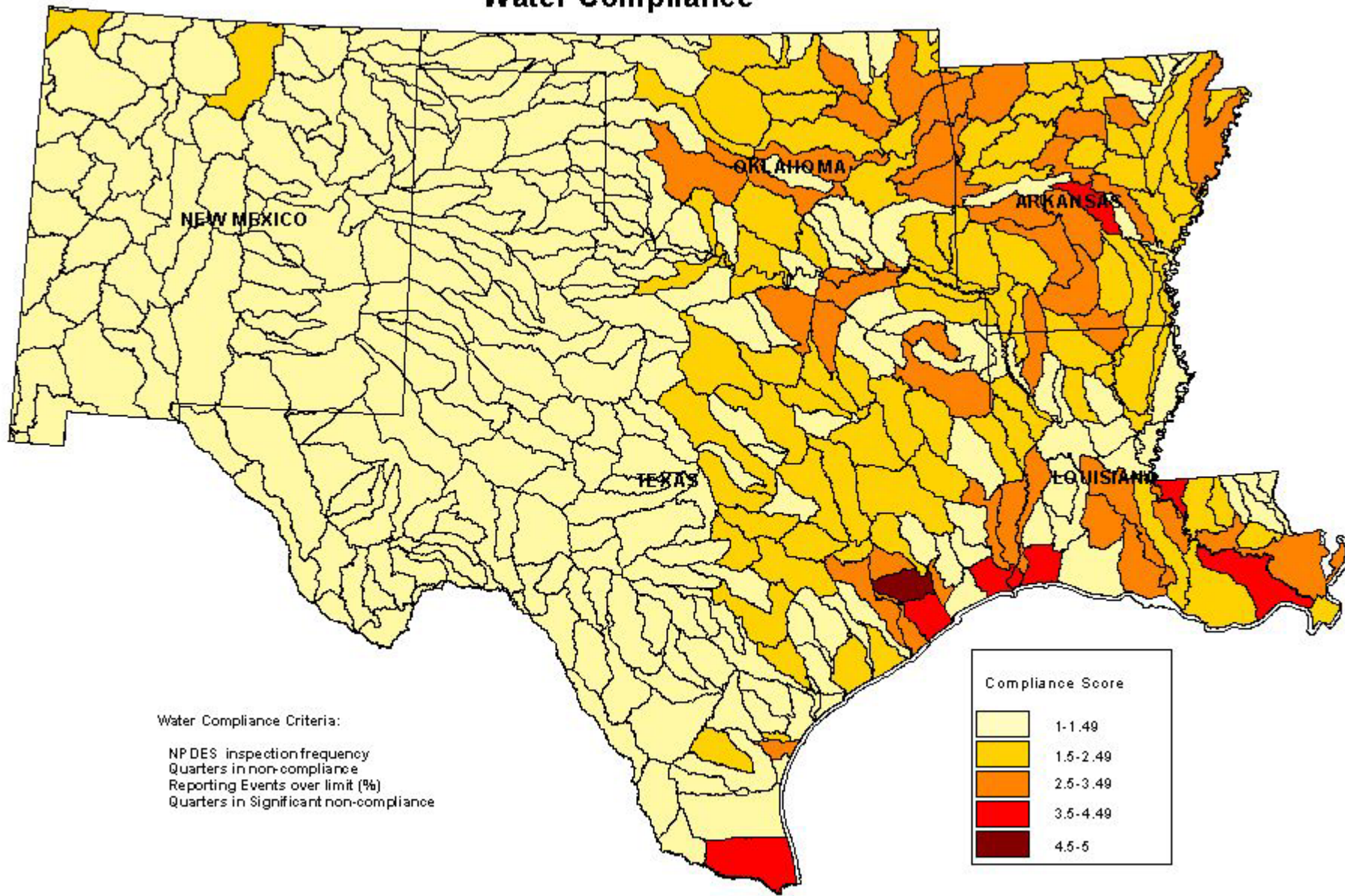# GIS Cumulative Risk Screening System

Allows us to do more … (60 - 90 indicators can be evaluated for several sites in 2 hours)

- **Modular Approach: All criteria are mathematically related, can be combined to meet cumulative program assessment needs**

- **Strengthens the environmental assessment process (consistent methods, use of EPA and other agency data)**

- **Peer Review (Lantana Report, ground truthing by academia and communities)**

Example 1: Enforcement Targeting Screening Level – Watershed Based

- **403 Watersheds in Region 6.**

- **43 targeting criteria used.**

- **Each environmental, socio-economic or enforcement related criteria was ranked on a 1 – 5 scale as to environmental concern.**

- **Scores were added and watersheds ranked.**

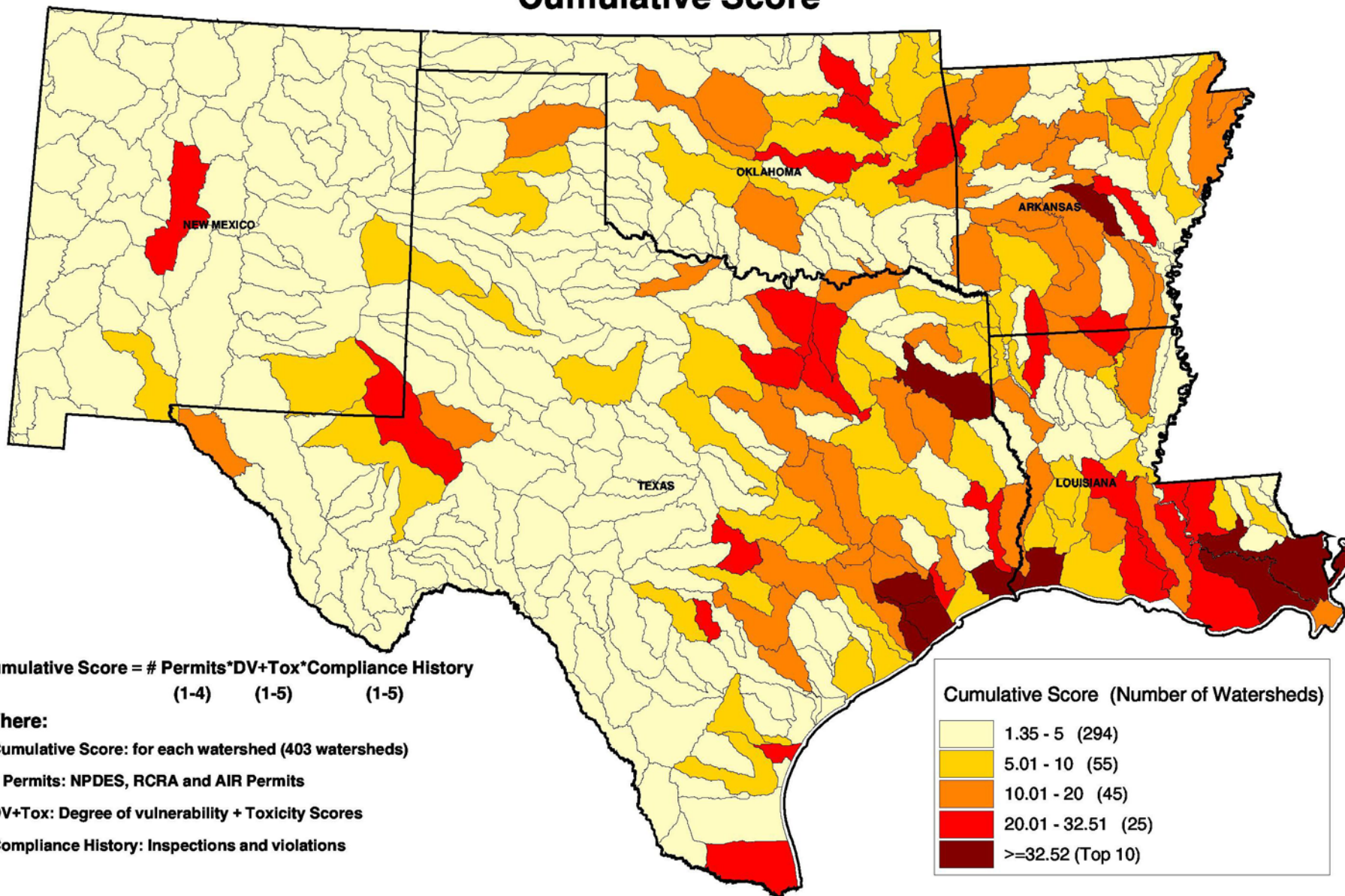- **Watersheds were targeted (industries within the areas were then evaluated).**

2000 Multimedia Enforcement Targeting
Water Compliance

NEW MEXICO

OKLAHOMA

ARKANSAS

TEXAS

LOUISIANA

Water Compliance Criteria:

NPDES inspection frequency
Quarters in non-compliance
Reporting Events over limit (%)
Quarters in Significant non-compliance

Compliance Score

	1 - 1.49
	1.5 - 2.49
	2.5 - 3.49
	3.5 - 4.49
	4.5 - 5

EPA Region 06
OIS Support Team
09/08/99

A   C   S

1 – 5 Scores For Water Compliance History Criteria

- Days from last inspection (<6 mos.=1, >2 yrs. or no data=5)

- Non-Compliant Qtrs (0 or ND=1, 7 to 8 Qtrs=5)

- Significant Non-Compliance Qtrs (0 or ND=1, 7 to 8 Qtrs=5)

- Percent Reporting Events (<6 mos.=1, >2 yrs. or no record=5)

- Watershed Score (sum of criteria scores)

2000 Multimedia Enforcement Targeting Cumulative Score

Cumulative Score = # Permits*DV+Tox*Compliance History

$$(1\text{-}4) \qquad (1\text{-}5) \qquad (1\text{-}5)$$

Where:

Cumulative Score: for each watershed (403 watersheds)

Permits: NPDES, RCRA and AIR Permits

DV+Tox: Degree of vulnerability + Toxicity Scores

Compliance History: Inspections and violations

Cumulative Score (Number of Watersheds)

- 1.35 - 5 (294)
- 5.01 - 10 (55)
- 10.01 - 20 (45)
- 20.01 - 32.51 (25)
- >=32.52 (Top 10)

EPA Region 06
GIS Support Team
09/03/99

A   C   S

0   300 Miles

RANK		HUCNAME	FAC_R	DVTOX	CIV_S	FINAL
Hou/TX	1	BUFFALO-SAN JACINTO	4	4.06	5.00	81.20
Hou/TX	2	WEST GALVESTON BAY	4	3.58	4.07	58.28
SE/LA	3	EAST CENTRAL LOUISIANA COASTAL	4	3.63	4.00	58.08
SE/TX	4	SABINE LAKE	4	3.54	3.60	50.98
SE/LA	5	EASTERN LOUISIANA COASTAL	3	3.59	3.40	36.62
E/TX	6	MIDDLE SABINE	3	3.26	3.55	34.72
SW/LA	7	LOWER CALCASIEU	3	3.46	3.27	33.94
Hou/TX	8	AUSTIN-OYSTER	3	3.78	2.93	33.23
LR/AR	9	LOWER ARKANSAS-MAUMELLE	3	3.17	3.48	33.09
SE/LA	10	LAKE MAUREPAS	3	3.83	2.83	32.52
E/TX	11	LOWER WEST FORK TRINITY	3	3.09	3.38	31.33
BR/LA	12	AMITE	3	3.44	2.98	30.75
NE/TX	13	ELM FORK TRINITY	3	3.09	3.27	30.31
BR/LA	14	BAYOU SARA-THOMPSON	3	3.96	2.53	30.06
NC/TX	15	UPPER TRINITY	3	3.13	3.13	29.39
LA	16	VERMILION	3	2.88	3.33	28.77
SE/TX	17	LOWER NECHES	3	3.45	2.77	28.67
S/TX	18	SOUTH CORPUS CHRISTI BAY	3	3.21	2.87	27.64
S/TX	19	SOUTH LAGUNA MADRE	3	3.19	2.87	27.47

Example 2: Houston Scrap Facility
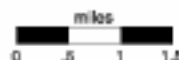## High Environmental Justice Concern Area

- **Use of Census Data**

- **Densely populated urban area (1 and 4 mile areas ranked a 3 on a 0-4 scale).**

- **High number of economically stressed residents (55.3% and 48.1% for 1 and 4 mile areas respectively).**

- **High index rankings for both the 1 and 4 mile radii (75 and 60 scores).**

Houston Scra, Harris, TX
Economic Status - Degree of Vulnerability (DVECO)
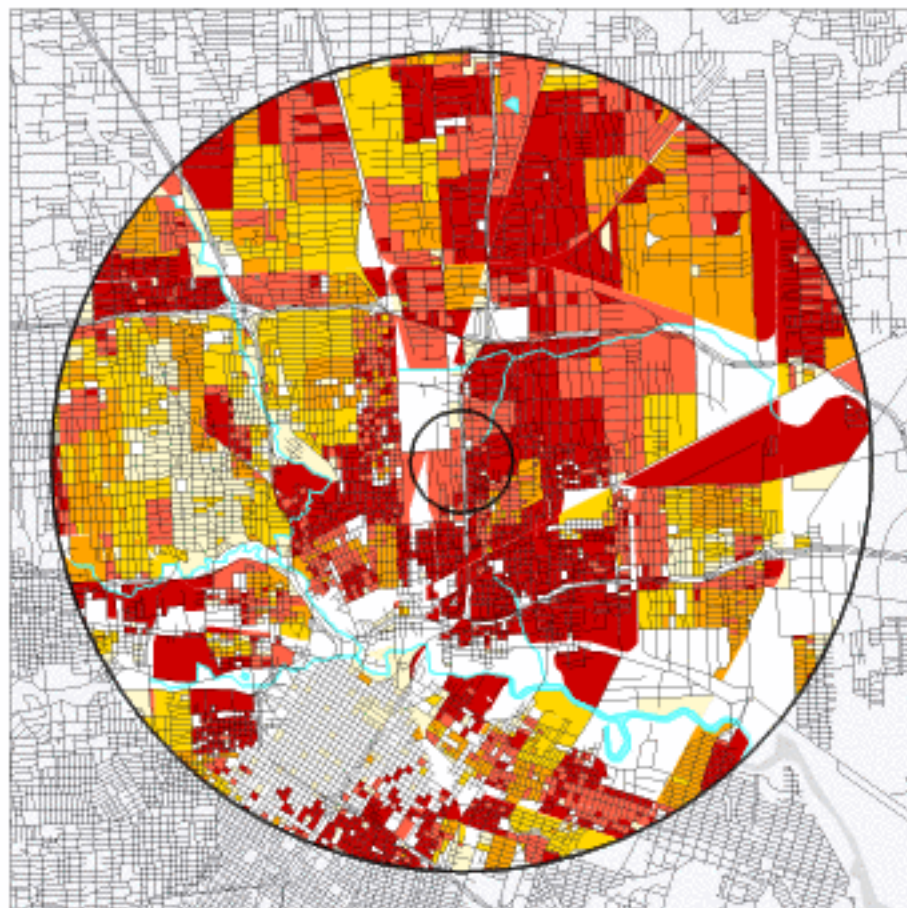
**Percent Economically Stressed
by Census Block Group
State Percentage = 27.6**

- <= the State Percentage
- > the State Percentage,
  <= 1.33 times the State Percentage
- > 1.33 times the State Percentage,
  <= 1.66 times the State Percentage
- > 1.66 times the State Percentage,
  <= 2 times the State Percentage
- > 2 times the State Percentage

Potential Environmental Justice Index for Two Study Areas	1 Sq. Mile	50 Sq. Mile
Total Population	4010	208386
Population Ranking (PF)	3	3
Percent Minority	99.3%	85.2%
Minority Status (DVMAV)	5	5
Percent Economically Stressed	55.3%	48.1%
Economic Status (DVECO)	5	4
Environmental Justice Index	75	60

Longitude: -95 20 24 Latitude: 29 47 30

miles
0   .5   1   1.5

Houston Scra, Harris, TX
Potential Environmental Justice Index (EJ)
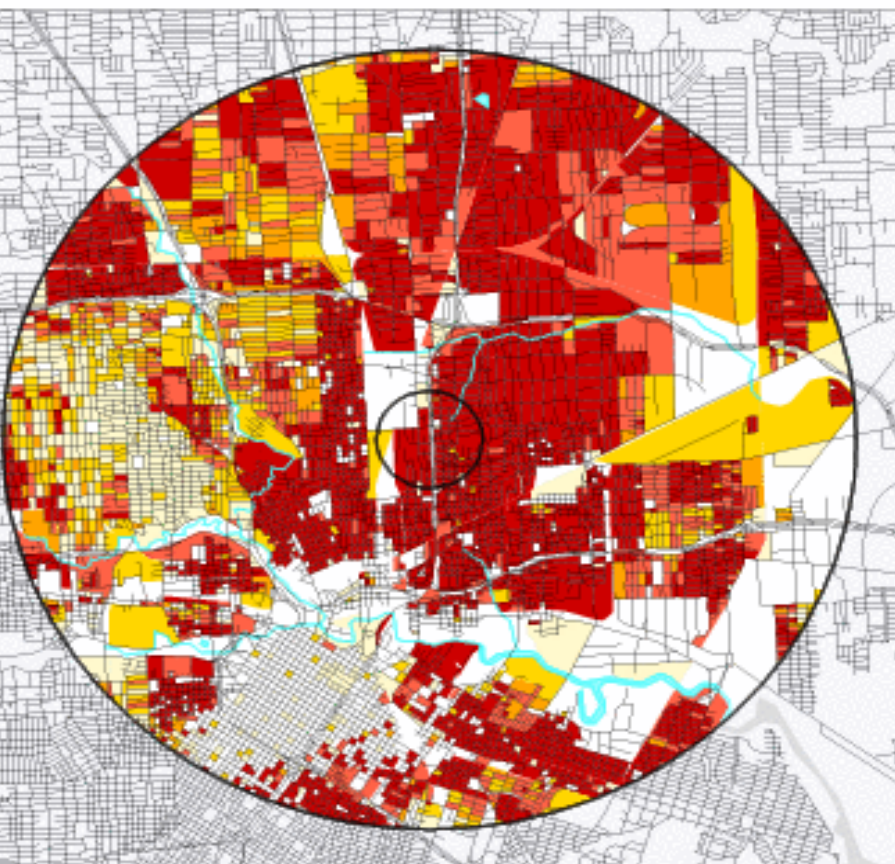
Criteria Ranked by Census Block (DVMAV * DVECO * PF)

- 1 to 12
- 13 to 25
- 26 to 37
- 38 to 50
- 51 to 100

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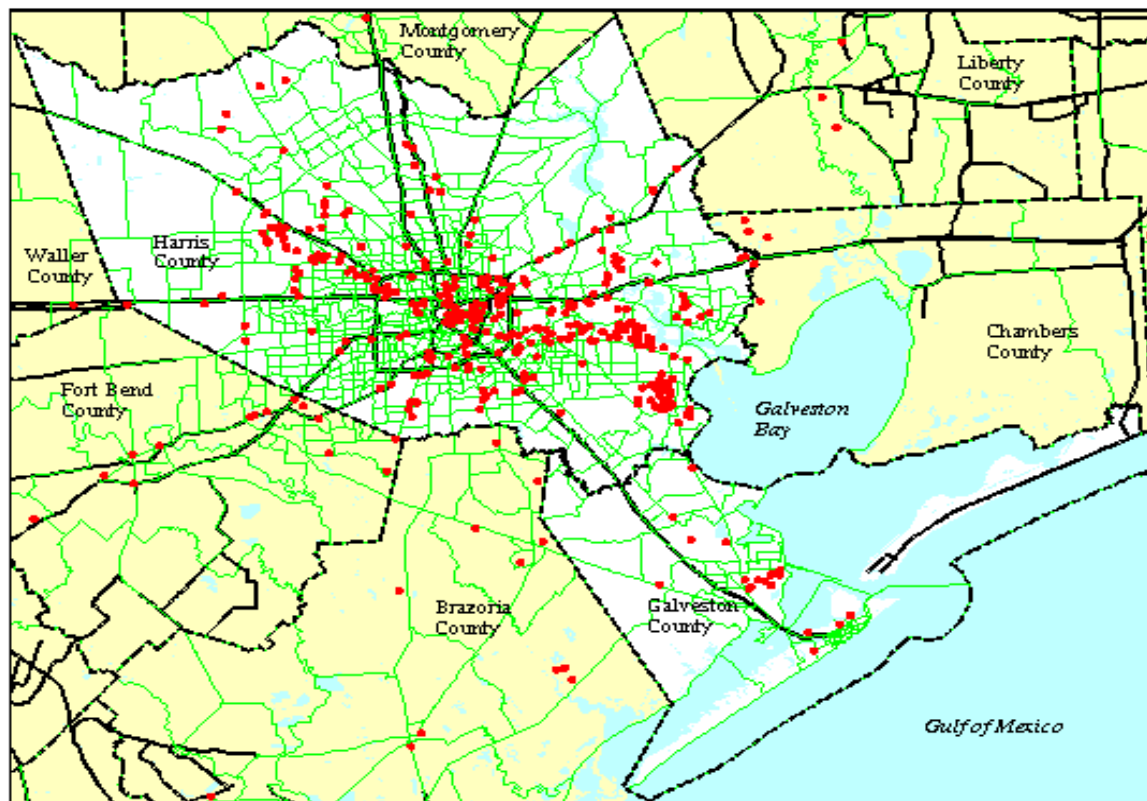
miles
0   .5   1   1.5

Data Sources and References: US Bureau of the Census, 1990 PL94-171 and STF3A Data, and TIGER Files
US EPA Region 6, 1992. Computer Assisted Environmental Assessment Methodologies, Chapter V. Special Applications,
Environmental Equity. Planning and Analysis Section, Management Division, Region 6 EPA, Dallas, Texas

Example 3: Houston – Galveston, Texas Screening Level Human Health Index Study

- **Over 400 Toxic Release Inventory (TRI) sites in the area.**

- **Each TRI chemical release was toxicologically assessed as to potential for heath risk (pounds released to air X toxicity score X bioaccumulation score)**

- **Possible chemical release impacts for multiple facilities were assessed (4 mile radii around each TRI site).**

- **Health risk index and EJ Index scores were calculated.**

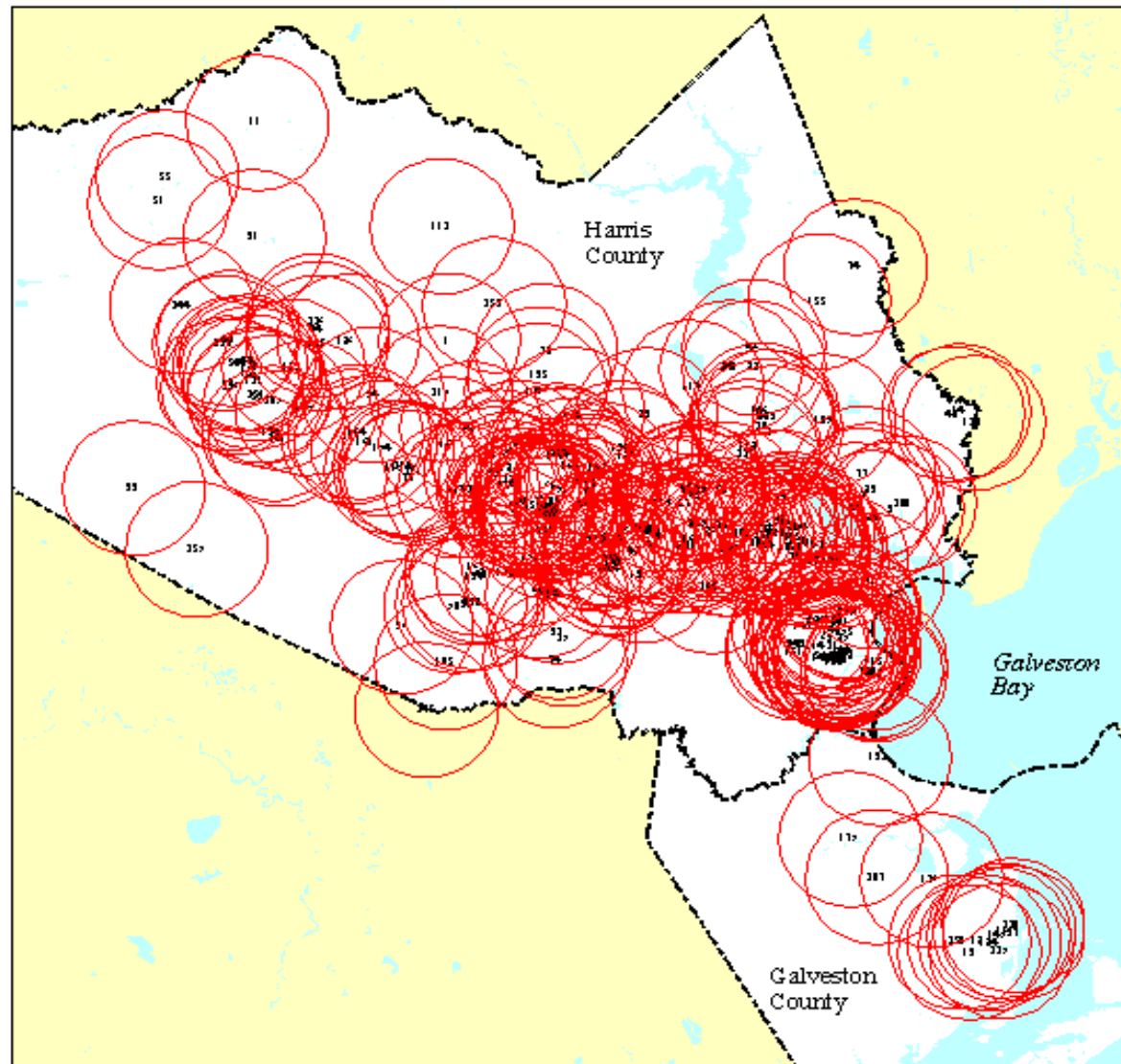# Community Based Multimedia Area
Galveston/Harris Counties
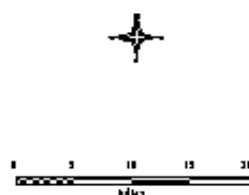
Legend:
- ● TRI Sites
- Census Tracts
- Major Roads
- County Boundaries
- Water Bodies

Montgomery County, Liberty County, Harris County, Waller County, Fort Bend County, Chambers County, Galveston Bay, Brazoria County, Galveston County, Gulf of Mexico

COMMUNITY BASED ENVIRONMENTAL PROTECTION

Harris
County

Galveston
Bay

Galveston
County

TRI Site - Facility reported release
to air and/or water in 1993

Example 4: CAFOs - Preliminary
Human Health Conceptual Model

Population/Receptors

- Infants
- Farm Workers
- Residents Visitors
- Minorities

Effects

- Methemo globinemia
- Acute Effects Respiratory Neurological
- NH$_3$, H2S, Microbials, Particulates
- Psychological, Aesthetics, Odors, Social, Economics

Assessment Endpoints

- Improve Human Health
- Improve Quality of Life
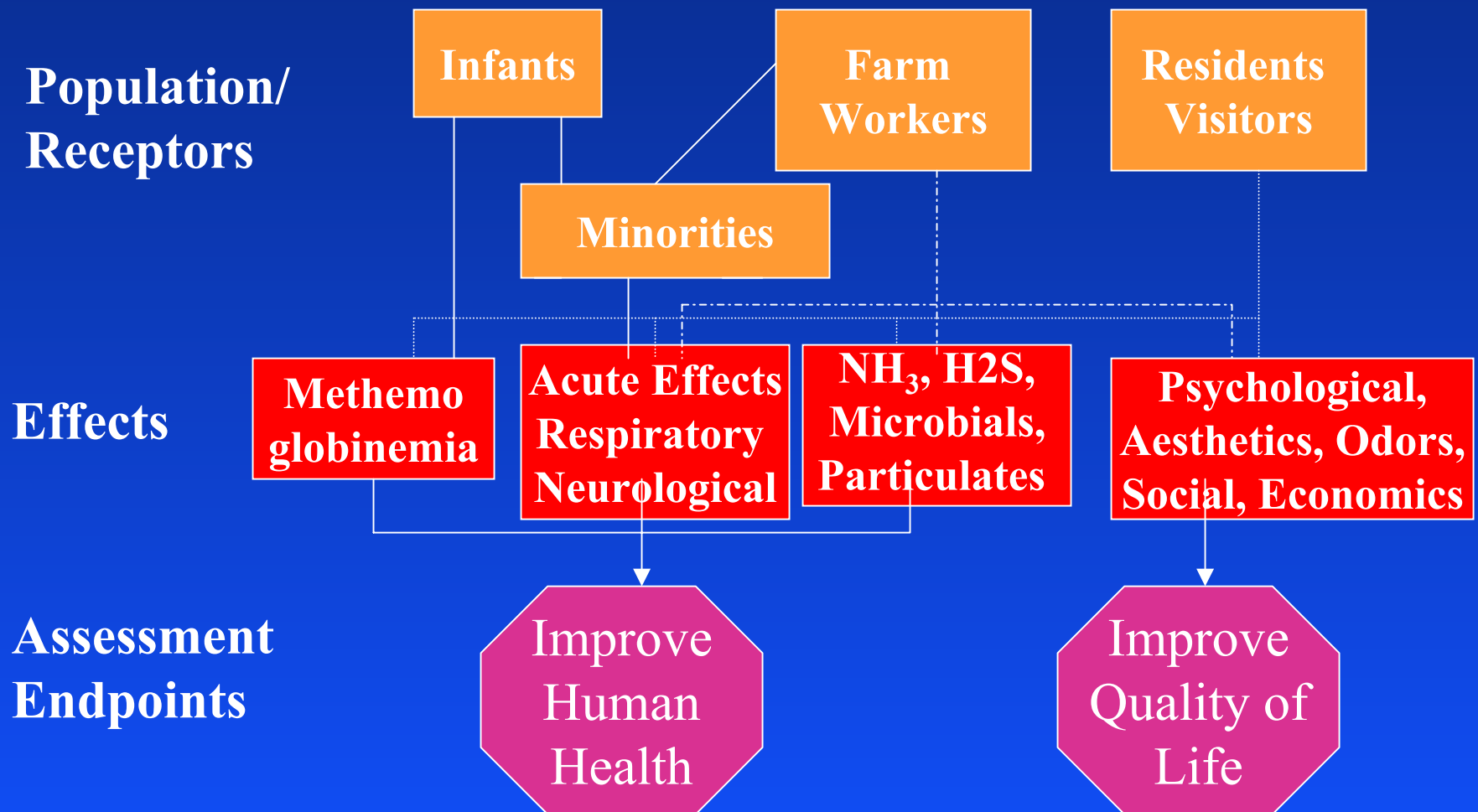
Ecological Preliminary Conceptual Model

Population/ Receptors

Communities
Aquatic

Terrestrial

Wetlands

Migratory Waterfowl

Other Species??

Effects

Ecotox
-Fish
-Wildlife

Habitat
Loss

Disease

Eutrophication

Assessment Endpoints

Improve Community Health

Protect Migratory Waterfowl

Protect Critical & End. Spp.
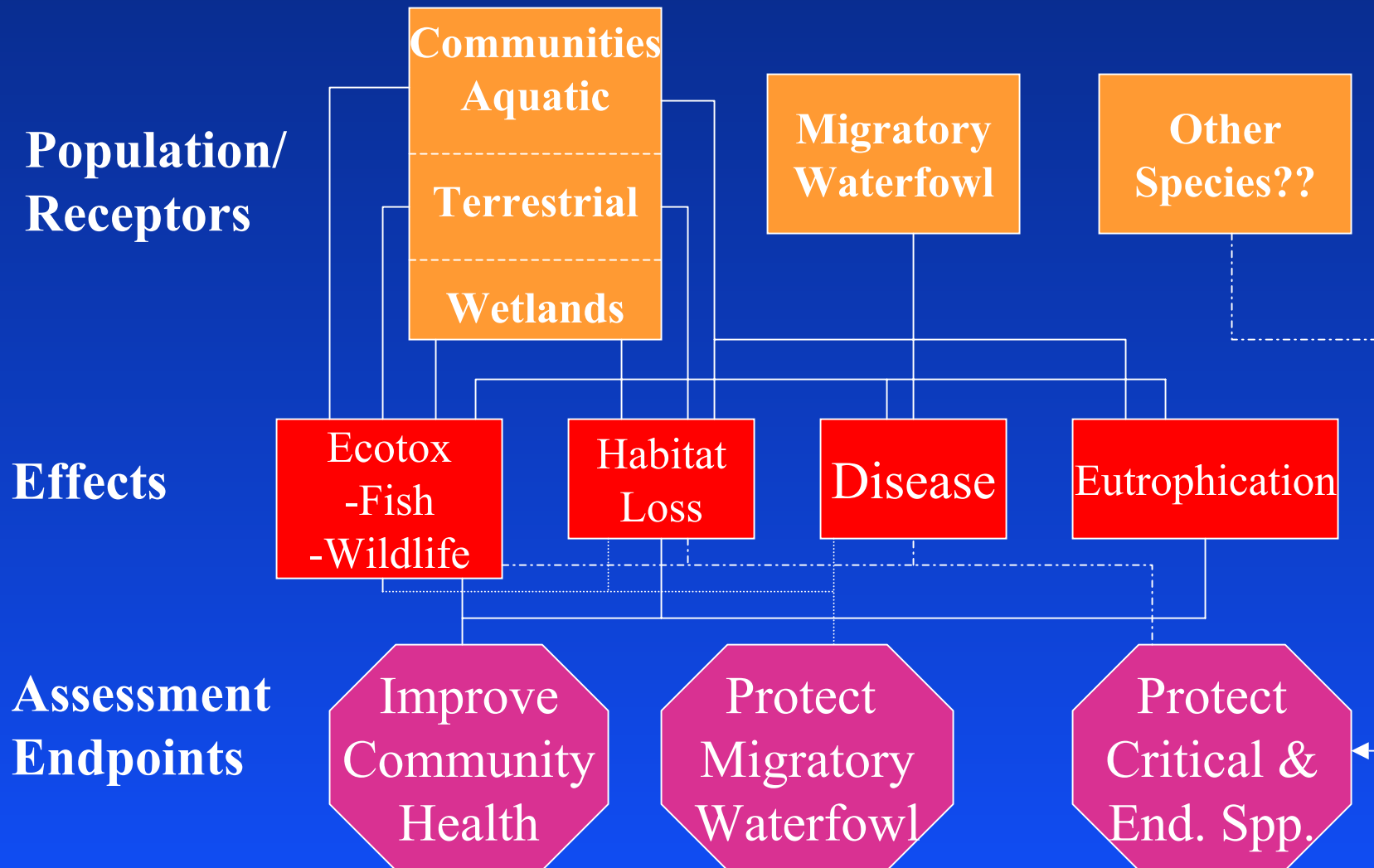
Pre-existing Sources

- Pre-existing sources in West Texas and Oklahoma include Oil and Gas Exploration and Production

- New Roads and increased traffic are a secondary effect of CAFOs in some areas

- Possible contributions from these sources to the set of stressors are shown.

Examples 5 and 6

Linear Projects – Highway Construction
Mustang to Tuttle Hwy Alignments
Louis Armstrong Airport Expansion
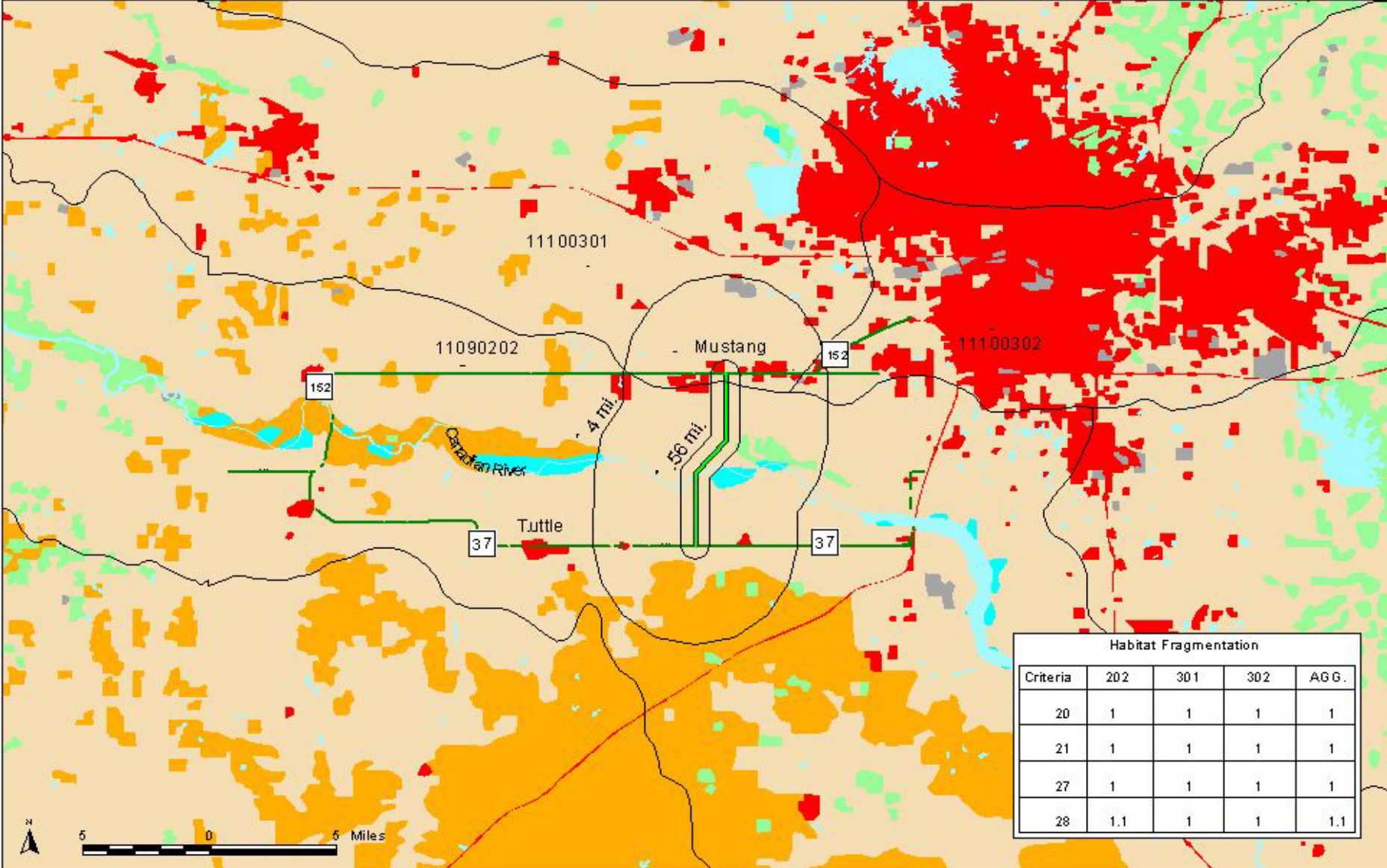
HOW DOES IT WORK?
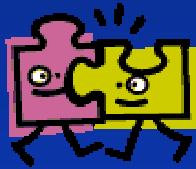
Area

defines the site as a % of the area
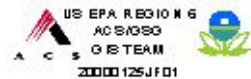
Vulnerability

characterizes the receptors

Impact

characterizes activities-stressors

11100301

11090202

Mustang

152

152

11100302

4 mi.

Canadian River

56 mi.

Tuttle

37

37

Habitat Fragmentation				
Criteria	202	301	302	AGG.
20	1	1	1	1
21	1	1	1	1
27	1	1	1	1
28	1.1	1	1	1.1

N

5   0   5 Miles

Tuttle, Oklahoma
Fragmentation Study

US EPA REGION 6
ACS/GSO
GIS TEAM
20000125JF01

Sources: US Census Bureau and USGS.

Map Features

—— Proposed Road

—— Road

—— HUC

Landuse

Non-Wildlife

Agriculture   Urban

Barrenland

Wildlife

Forest   Wetland

Water   Rangeland

Tuttle, Oklahoma
Fragmentation Study

WILDLIFE HABITAT

Measure- Habitat Land Cover.

Definition- Percentage in key categories.

Data Source- Nat'l Land Cover Data (92/3).

Criteria- Watersheds scored based on %.

<u>Results</u>- Canadian – Walnut watershed most
impacted.

Watershed	Canadian - Walnut	Middle N. Canadian
Percent Habitat in Watershed	23.1 %	31.9%
Percent Habitat in 4 mile zone	20.3%	0%
Percent Habitat in 0.56 mile zone	0.3%	0%

Fragmentation

Measure - Wildlife habitat perimeter to area ratio

Definition- for HUC and each linear zone.

Data Source- Nat'l Land Cover Data (92/3).

Watershed	Canadian - Walnut	Middle N. Canadian
Perimeter to area ratio - HUC	0.84	0.88
Perimeter to area ratio - 4 mi.	6.23	0
Perimeter to area ratio- .56 mi	11.79	0

Highway Segment Criteria

NEPA Issue- Cultural Resources

Definition- cemeteries, churches, historical buildings

Data Source- TIGER (Census Bureau) & GNIS (USGS)

Criteria- Alignment in or out of area.

Results- Area subject to Section 4f or other issues.

Highway Segment Criteria

NEPA Issue- Parks (Managed Lands)

Definition- boundary files.

Data Source- UC-Santa Barbara/TIGER (Census Bureau)

Criteria- Alignment in or out of area.

Results- Area subject to Section 4f or other issues (habitat).

Highway Segment Criteria

NEPA Issue- Water

Definition- hydrographic features

Data Source- TIGER (Census Bureau)
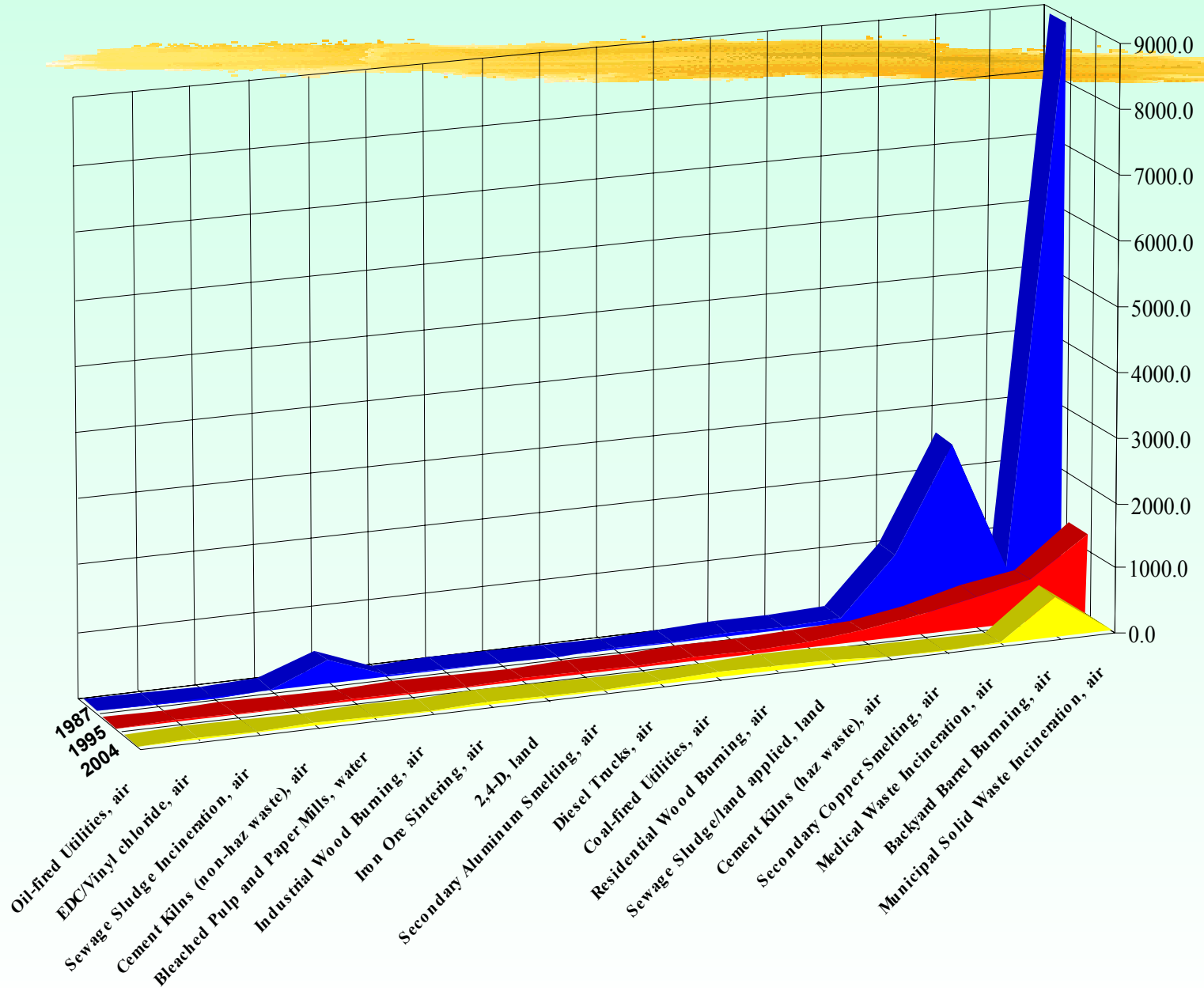
Criteria- Clean Water Act assessments

Results- identifies waters with known or potential problems.

Cancer Risk Factors
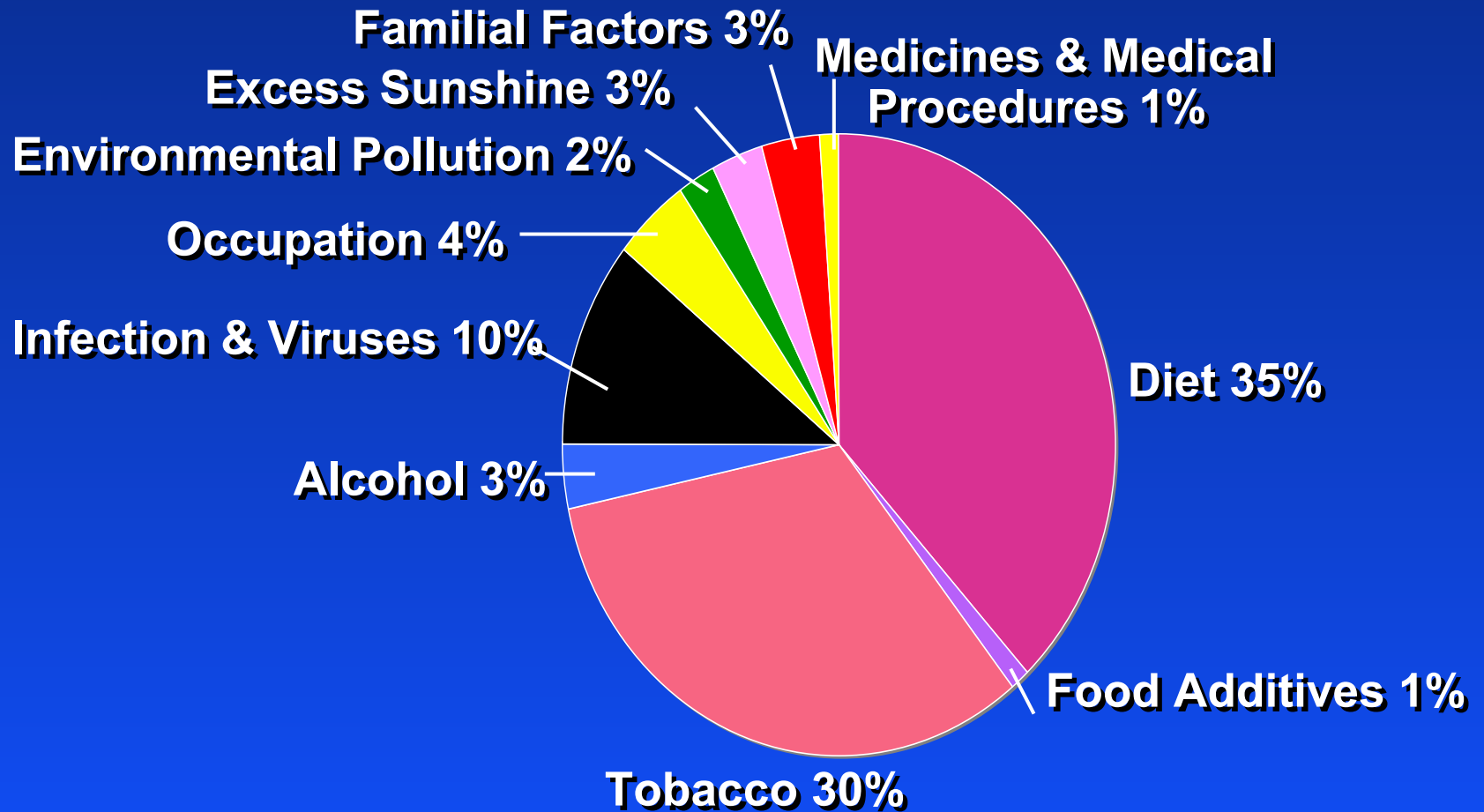
Familial Factors 3%

Excess Sunshine 3%

Environmental Pollution 2%

Occupation 4%

Infection & Viruses 10%

Alcohol 3%

Medicines & Medical Procedures 1%

Diet 35%

Food Additives 1%

Tobacco 30%

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